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NOTES ON THE PALEOZOIC FAUNAS AND STRATIGRAPHY OF SOUTHEASTERN ALASKA[1]

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INTRODUCTION

The localities referred to in this paper are located on the islands of the Alexander Archipelago and along the shores of the narrow coastwise strip west of British Columbia sometimes called the Panhandle of Alaska.

During the summer of 1905 the writer, in company with Mr. C. W. Wright, made a boat journey of about 600 miles along the coasts to the southeast of Glacier Bay and the Lynn Canal. Collections were made from nearly all of the localities at which fossils had previously been found in this region by Mr. Wright and others, and from a number of new ones.

The trip was undertaken primarily for the purpose of aiding in the work of correlating and mapping the rocks of southeastern Alaska, upon which Messrs. F. E. and C. W. Wright have for some time been engaged. Alaskan faunas have a wide general interest to paleontologists, owing to their intermediate position between the faunal provinces of America and Asia. So little has been published on the faunas of this important region that a preliminary statement of the results thus far obtained seems justified in advance of the comprehensive work of the Wrights. A brief statement of the stratigraphic succession is essential to the comprehension of the summary of the faunas. In presenting this outline of the stratigraphic succession the writer wishes to acknowledge his indebtedness to previous workers in this region, and particularly to the Wrights, upon whose work it is in part based. More explicit reference to the previous work in the region is offered in the following brief discussion of the more important contributions relating to this field.

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LITERATURE

Casual observations on the Paleozoic rocks of southeastern Alaska appear in the writings of some of the travelers who visited the region during Russian occupation. The most important of the early papers is one by Dr. Grewink, a Russian, who, although he never visited Alaska, published a paper in 1850[1] which contains many geographical and some geological data concerning southeastern Alaska. This work is based largely on collections and data obtained by a Russian naval officer. The finding of a loose specimen of the Silurian fossil *Catenipora escharoides* near Sitka is reported by Grewink.[2]

In 1855 Isbister published a summary of then existing knowledge of the geology of northwestern America, with a geological map which included Russian America.[3] The data relating to southeastern Alaska[4] are drawn from Grewink and the "Geological Appendix" to Captain Beecher's *Voyage to Behring Straits.* The crude inaccuracy of the map made it of little or no value as a basis for actual work in the region.

In 1863 Mr. W. P. Blake made a reconnaissance of the Stikine River and published some notes on the rocks observed.[5] In 1868 Mr. T. A. Blake published a paper[6] on southeastern Alaska which contains observations on the lithologic characters of the rocks near Sitka and along Chatham Strait.

The pioneer work of George W. Dawson on the Chilkoot Pass and Stikine River[7] sections in 1888, and of C. W. Hayes along the Taku Inlet and River in 1891,[8] was the first important contribution to our knowledge of the stratigraphy of southeastern Alaska. These three traversers of the coastwise belt established the fact that the sedimentaries are cut by a granite belt of great width and length.

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[1] "Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West-Küste Amerikas mit den anliegenden Inseln," *Verhandlungen der Russischen kaiserlichen mineralogischen Gesellschaft zu St. Petersburg,* 1848, 1849 (1850), pp. 76—432.

[2] *Ibid.,* p. 93.

[3] *Quarterly Journal of the Geological Society of London,* Vol. XI (1855), pp. 497–520, map.

[4] *Ibid.,* pp. 518, 519.

[5] *Petermans Mitteilungen,* Vol. X (1864), pp. 171–75. 4°.

[6] *American Journal of Science,* Second Series, Vol. XLV (1868), pp. 242–47.

[7] *Annual Report of the Geological Survey of Canada,* N. S., Vol. III, Part 1, pp. 53*b*–59*b*, 176*b*.

[8] *National Geographical Magazine,* Vol. IV (1892), pp. 117–59.

In 1892 Mr. H. P. Cushing, a member of Professor Reed's party, published a paper on the bed-rock geology about Glacier Bay, which includes a report on a small collection of fossils from a limestone having "a thickness of several thousand feet." These were determined by Professor H. S. Williams as Paleozoic.[1] Later this collection, with the addition of a coral which appears to have been obtained from a glacial moraine, was reported to be Carboniferous on the authority of Professor Williams.[2] Professor J. J. Stevenson, who obtained the coral considered it and the Leperditias to indicate a horizon "not younger than Middle Devonian."[3]

Professor H. F. Reid in 1895 published a report on "Glacier Bay and Its Glaciers,"[4] in which he quotes this determination by Williams of the Carboniferous age of the Glacier Bay limestones. On the basis of this determination Reid suggests the correlation of the Glacier Bay "Carboniferous" and some of the argillites and limestones described by Hayes in the Taku section, 100 miles to the eastward, with the Glacier Bay limestones. The Cambro-Silurian age of the argillites underlying the limestone at Glacier Bay is suggested by Reid because of a supposed analogy of his section to one of Dawson's some 300 miles to the southeast, in which Carboniferous faunas are said to follow a Cambro-Silurian horizon. The Cushman fossils were later examined by Schuchert, who reported them to be Silurian, with the exception of the coral from the moraine, concerning which Schuchert agreed with Stevenson in reporting it to be an *Acervularia*, representing a Devonian horizon.[5] Fossils recently collected by the Wrights leave no question as to the Silurian age of the Glacier Bay limestones.

In 1895 Messrs. Dall and Becker visited southeastern Alaska in order to study its gold and coal resources. The observations on the stratigraphy in Mr. Becker's paper[1] relate to the rocks in the vicinity of the gold mines. No correlations with rocks elsewhere are attempted.

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[1] *National Geographical Magazine*, Vol. IV (1892), p. 59.

[2] *Sixteenth Annual Report*, U. S. Geological Survey, Part 1, p. 434.

[3] *Scottish Geographical Magazine*, Vol. IX (1893), p. 70 (separate p. 5).

[4] *Sixteenth Annual Report*, U. S. Geological Survey, Part 1, pp. 433, 434.

[5] Brooks, *Professional Papers No. 1*, U. S. Geological Survey, p. 20.

Dall's paper, which relates solely to post-Paleozoic rocks, has attached as an appendix a paper by Charles Schuchert.[2] This paper gives a list, with notes, of fossils obtained at Kuiu Island by Messrs. Dall, Becker, and Brightman. Professor Schuchert referred these fossils to two horizons, the Devonian and Carboniferous. It will be shown elsewhere in this paper that all of these fossils are of Upper Carboniferous age.

In 1901, Mr. Alfred H. Brooks,[3] incidental to a study of the mineral deposits of the Ketchikan district, collected considerable data on areal and structural geology. He also carried a hasty reconnaissance northward as far as Skagway, and thence westward to Sitka. In his report he brought together, not only his own data, but also those of previous investigators, and included a geologic sketch map of southeastern Alaska and a provisional table of correlations.

Mr. Arthur C. Spencer[4] in 1903 made a study of the geology and mineral resources of a strip of the mainland extending southward from Berners Bay to Snettisham, while in the same year Mr. C. W. Wright[5] carried a reconnaissance northward to the international boundary in the Porcupine district, in which he has shown the presence of a Carboniferous limestone. Since then Messrs. F. E. and C. W. Wright have extended their work so as to cover nearly the entire province, but only their preliminary statements have been issued. Accompanying one of these is a preliminary geological map[6] covering most of the area.

Professor B. K. Emerson, one of the geologists of the Harriman expedition, has published some notes on the lithology and correlation of the rocks at points where their steamer touched.[7] Most of these relate to Mesozoic terranes. In his observations on Glacier Bay Professor Emerson revives an old error by referring the limestones of that locality to the Carboniferous,[1] unaware, apparently, that they had been shown to be of Silurian age.[2]

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[1] *Eighteenth Annual Report,* U. S. Geological Survey, Part 3 (1898), pp. 7–86, 96, 97.

[2] "Report on Paleozoic Fossils from Alaska," *Seventeenth Annual Report,* U. S. Geological Survey, Part II, pp. 898–906.

[3] *Professional Paper No. 1,* U. S. Geological Survey, pp. 1–119; *Bulletin of the Geological Society of America,* Vol. XIII (1901 [1902]), pp. 253–66.

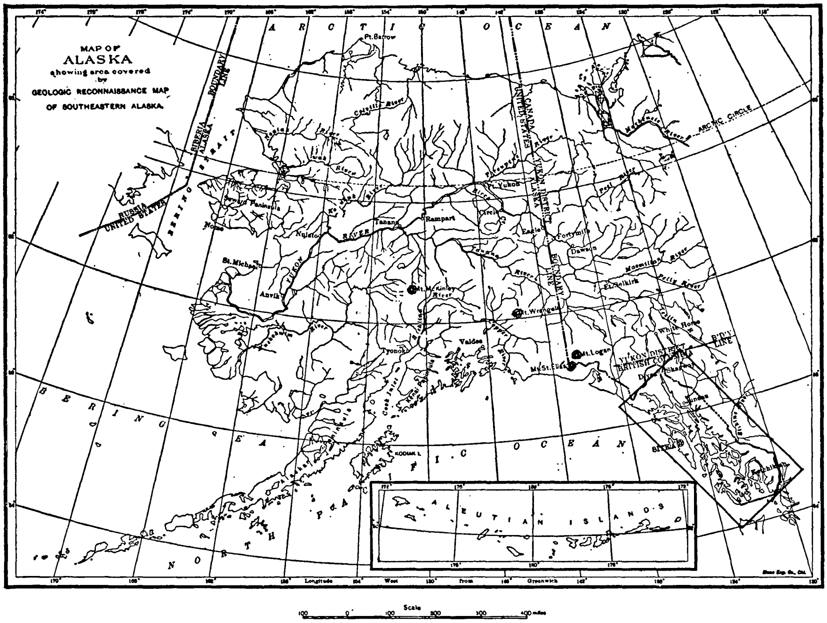
[4] *Bulletin No. 287,* U. S. Geological Survey, 1904 (1907).

[5] *Bulletin No. 236,* U. S. Geological Survey, 1904.

[6] *Bulletin No. 284,* U. S. Geological Survey, 1906, pp. 30–54, Plate 11.

[7] *Ibid.,* p. 20.

Quite recently Brooks has briefly summarized the more essential facts concerning the stratigraphic succession in southeastern Alaska.[3] A small-scale geologic map of the whole of Alaska, so far as covered by surveys, accompanies this report. In this paper appears the first notice of the presence of Silurian horizons at Freshwater Bay and Kuiu Island.



GENERAL GEOLOGIC RELATIONS

Southeastern Alaska is a region in which a wide range of geologic agencies have operated to produce a complex and intricate stratigraphic record. Volcanic and igneous rocks, either as surface flows or as intrusions, have been developed in this area at frequent intervals from the Paleozoic down to the present. The sedimentary beds are known to include Tertiary, Mesozoic, and Paleozoic horizons as far back as the Silurian. By far the greater part of the sedimentaries belong to the Paleozoic, but a considerable thickness of the Mesozoic has been found in a few sections. The Mesozoic and Paleozoic beds have been folded together in a series of flexures, generally of the open fold type after which the Tertiary, now found only in a few isolated basins, was deposited upon them. The general direction of the strike of the beds is northwesterly and southeasterly, approximately parallel to the coast-line. The inclined beds have been cut by extensive intrusions. These take courses parallel in a general way to the strike of the sedimentaries. The granites, which comprise the bulk of the Coast Range mountains, are the most important of these intrusive masses. This granite belt has a width of 40 to 80 miles, and extends the entire length of the coast strip and beyond it both north and south. Granite intrusions, which are usually more or less local in character, occur through the islands. The older rocks over considerable areas in some parts of the region are buried under lavas of Tertiary age.

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[1] *Harriman Alaska Expedition,* Vol. IV (1904), pp. 16–23.

[2] A. H. Brooks, *Professional Paper No. 1,* U. S. Geological Survey, 1902, pp. 19–21.

[3] "The Geography and Geology of Alaska," *Professional Paper No. 45,* U. S. Geological Survey, 1906, pp. 208, 210, 211, 219, 221, 222.

The shales and limestone of the sedimentary series have in many parts of the region been altered to marbles and schistose rocks by the intrusives and deformational agencies. Frequently the alteration has been sufficient to destroy all traces of organic remains.

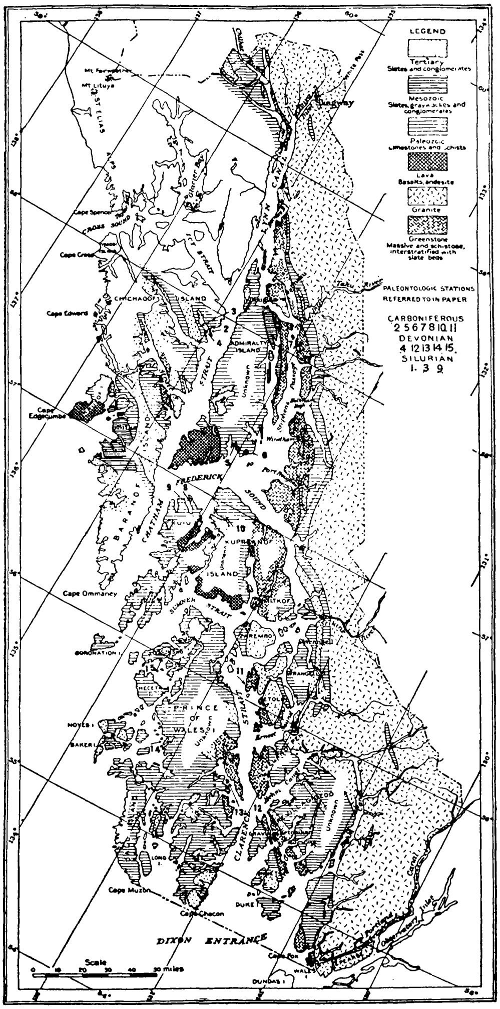
The general order of the stratigraphic succession is shown in the following table:

PROVISIONAL TABULAR STATEMENT OF STRATIGRAPHY

Age		Lithological Character	Correlation with Nomenclature of Brooks*	Thickness Feet
Carboniferous	Upper Carboniferous	Light-colored limestone	Ketchikan series	600±
	Middle Carboniferous	Argillites, cherts, shales, sandstone, and greenstone		?
	Lower Carboniferous	Dark-gray limestones and interbedded cherts		1500±
Devonian	Upper Devonian	Dark-red volcanic material, limestone and greenstone	Vallenar series	?
	Middle Devonian	Gray limestone		200±
	Lower Devonian	Gray limestone		200±
Silurian		Gray and buff limestones	Wales series	3000±
Silurian or pre-Silurian		Graywacke, cherts, and some dark limestone		?

* *Professional Paper No. 1*, U. S. Geological Survey, 1902, pp. 41–45.

The limits of the three subdivisions or series of the Paleozoic proposed by Brooks, which are shown in the preceding table, correspond to those of the Carboniferous, Devonian, and Silurian rocks of the region, so far as they were recognized at that time.



Our present knowledge of the section is too incomplete to make any definite statements concerning the contact relations of the several divisions of the column. While it is probable that unconformities exist within the Paleozoic, evidence of them has not been observed by the writer.

Brooks observed what he considered evidence of unconformity at the base of the Devonian at Long Island (13)[1] and Vallenar Bay (12).[1] It may be stated, however, that at neither of these localities is the age of the "older beds" known. The evidence of unconformity consequently rests on the character of the contact between the Devonian and the older beds. This relationship, as observed by the writer at Long Island, appears to be open to another possible interpretation than that of unconformity. On the north side of Long Island the relative position of the limestone and inferior beds may be the result of a fault which has lifted the basal igneous beds considerably higher than the limestone at one or more points. On the south shore the strike and dip of the limestones and the underlying igneous beds, which probably represent submarine volcanic flows, were in harmony where observed. In referring to this supposed unconformity the writer wishes not to deny its existence, but to point out that further evidence is required to demonstrate it.

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[1] Numbers refer to collecting stations on map. *Professional Paper No. 1*, U. S. Geological Survey, 1902, p. 21.

The preliminary geological map by Messrs. F. E. and C. W. Wright is here reproduced[1] in order to show the location of the points from which the fossils on which this paper is based were obtained. The several collecting stations are indicated by numbers, and the horizon of each is shown by a geological grouping of the numbers at the margin of the map.

SILURIAN

The oldest fauna which has been found in the region is of Silurian age. A great thickness of rocks, mostly argillites, underlies the limestones holding Silurian fossils. These lower beds, in which no fossils have been found, have an aggregate thickness of several thousand feet, as exposed on the west coast of Kuiu Island. The great thickness of these beds and their position below limestones known to be of Silurian age strongly suggest their pre-Silurian age, although no paleontologic evidence of this has been obtained.

Two horizons of the Silurian have been recognized. The older of these is represented by a small fauna which has been found on the northwest coast of Kuiu Island (10).[2] In the limestones northeast of Mead Point the following fauna occurs:

Diphyphyllum ? sp.
Conchidium knighti (Sow.)
Whitfieldella sp.
Holopea cf. servus Barr.
Murchisonia sp.

None of the species are abundant, with the exception of *C. knighti*, which is represented by great numbers of large shells in one thin bed of limestone.

C. knighti is one of the characteristic fossils of the Aymestry limestone of the Ludlow group of England. It is known also from

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[1] Republished from *Bulletin No. 284*, U. S. Geological Survey, 1906.

[2] Locality numbers refer to the map.

Russia and Bohemia. There appear to be no authentic records of its occurrence in the Silurian faunas of the United States. The nearest equivalent of this fauna in eastern America is the Niagara fauna. While none of the species collected are identical with Niagara species, *Conchidium knighti* is very closely related to *C. nysius* of the Niagaran fauna.

The Kuiu island fauna occurs in the midst of a limestone series which appears to be 2,000 feet or more in thickness. Other portions of the series which were examined appeared to be barren. Upward these limestones seem to terminate with volcanic breccias, while below they pass into cherts and argillites of undetermined age.

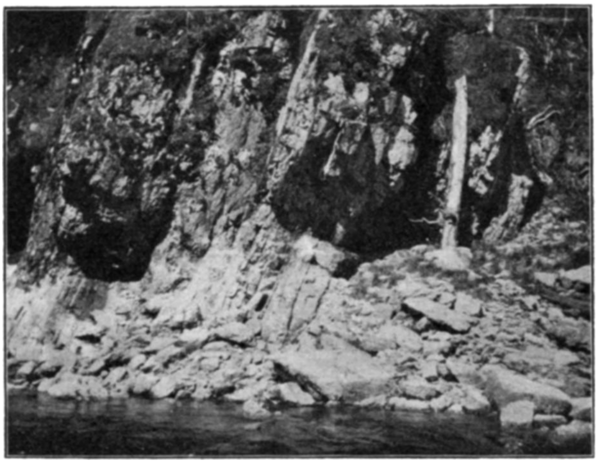

FIG. 1.—Silurian beds at Freshwater Bay.

The later Silurian horizon does not appear to be present in the Kuiu Island section. It occurs at Freshwater Bay (4), where more than a thousand feet of gray limestones, which precede the beds carrying Devonian fossils, outcrop along the south side of Freshwater Bay. The appearance of the lower portion of this series is shown in the accompanying photograph (Fig. 1). The lower two-thirds of this series comprises dark-gray, thinly laminated limestones. *Leperditias* of an undetermined species occur abundantly in certain beds in the lower part of the series. A few fragments of another and larger crustacean, probably a *Ceratiacaris*, are associated with them.

These crustaceans comprise the fauna of the lower 700 feet of the section, so far as discovered.

In the upper 300 feet of the limestones of the section a crustacean fauna also predominates, but the types represented are unlike those of the preceding division. One of the conspicuous forms in this fauna is a large undescribed ostracod provisionally referred to *Isochilina* by E. O. Ulrich, having a length of 1¼ inches. Fragmentary specimens indicate the presence of one or more other species of large ostracods, which together with a new species of *Ceratiacaris* are associated with the large *Isochilina*. Other forms occurring in this portion of the section are *Zaphrentis?* sp., represented by a single specimen, *Meristella tumida* Dalm.? and *Megalomus* sp. undt. The *Megalomus* is a large and very thick-shelled bivalve comparable in this respect with *Megalomus canadensis* of the Guelph, and identical with a species occurring in the limestone at Glacier Bay.

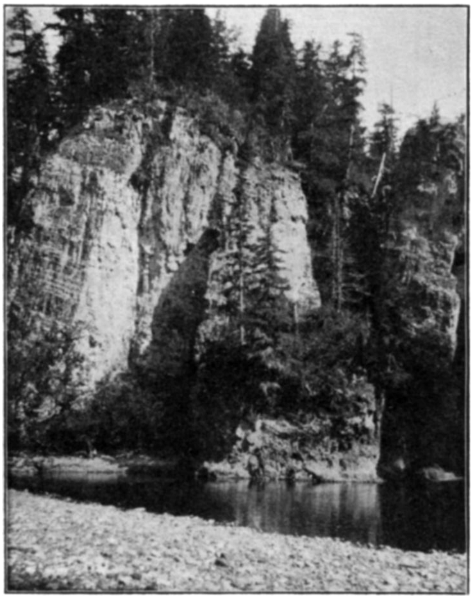

FIG. 2.—Upper Carboniferous limestone, Hamilton Bay, Kupreanof Island.

While none of the forms occurring in the two lowest divisions of this section have been identified with known species, the dominance of the large ostracods and the massive-shelled *Megalomus* and thick-shelled *Murchisonias* point to a late Silurian age of the fauna. The horizon represented is apparently about that of the Guelph.

The Silurian fauna of Freshwater Bay is found also at Glacier Bay, to the northwest. A small collection in the National Museum made by Cushman, and a much larger collection by Mr. F. E. Wright, show the faunas of the two localities to bear the closest resemblance.

The horizon represented by the fauna at Freshwater and Glacier Bays is not known as yet elsewhere in Alaska. The Kuiu Island Silurian fauna differs very materially in its facies from other known Silurian faunas of Alaska, but the same horizon appears to be represented by the Silurian found by the writer on the Porcupine River, in northeastern Alaska, during the last summer.

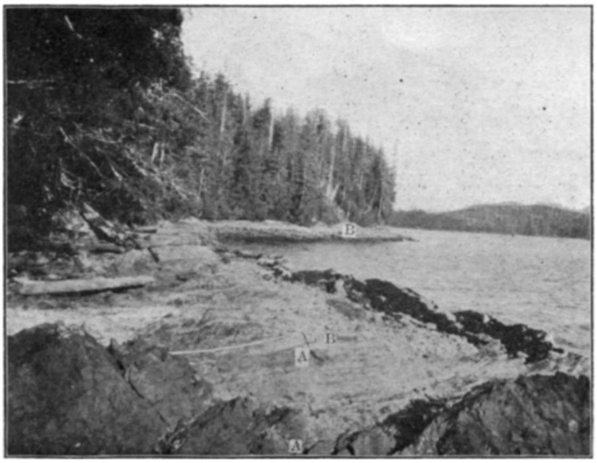

FIG. 3.—Lower Devonian limestone (*B*) and basal igneous beds (*A*) at Long Island.

DEVONIAN

No complete section of the Devonian is known in southeastern Alaska. The collections from various points taken together, however, show the presence of Upper, Middle, and Lower Devonian horizons. The earliest fauna of the Devonian which has been found occurs in the section at Long Island, Kasaan Bay (13). The bedrock of the shores of the bay is composed chiefly of the Kasaan greenstones and cherts. The limestone of Long Island and its associated igneous rock is supposed to be interpolated in the greenstone series. The surface rocks of the island comprise a limestone series resting on a bedded igneous rock, with which the limestones appear to be conformable. Both series are shown in Fig. 3. An estimate of the thickness of the beds along the south shore of the island gives the following section exposed between the east end of the island and the inlet to the Salt Pond:

	Feet
c. Hard, dark-gray limestone, slightly darker than *b*	270
b. Hard, blue, fine-grained limestone, fracturing easily in any direction	200
a. Stratified buff or cream-colored siliceous beds of igneous origin	90
	560

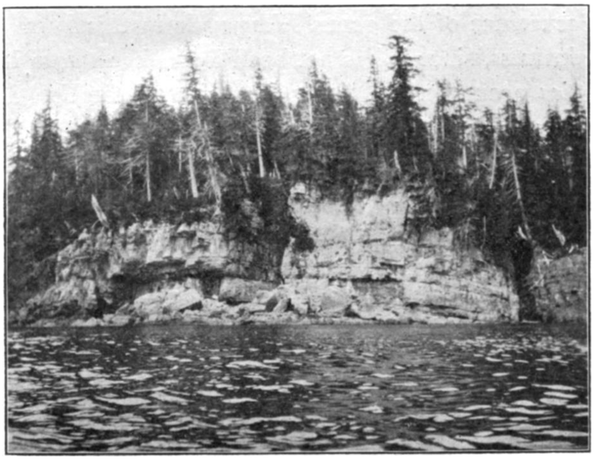

FIG. 4.—Middle Devonian limestone, Long Island.

The two divisions of the limestone series are conformable with each other, and the upper and lower portions are very similar in lithologic characters. Fig. 4 shows the lower beds of division *c*. The faunas of the two divisions of the limestone, however, show marked differences. The fauna of the upper portion of the limestone series was first discovered by Brooks, who collected some fossils from it which Schuchert determined as Middle Devonian.[1] The lower fauna appears not to have been represented in the collection studied by Schuchert. The character of the fauna in the lower portion of the limestone series is indicated by the following list:

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[1] *Professional Paper No. 1*, U. S. Geological Survey, p. 43.

Stictopora sp.
Cladopora sp.
Delthyris sulcatus Hisinger.
Sanguinolites sp.
Cardiola sp.
Hercynella nobilis Barr.
Hercynella bohemica Barr.
Holopea sp.
Murchisonia angulata Phillips.
Murchisonia sp. 1
Murchisonia sp. 2

Planitrochus sp.
Planitrochus near amicus(Barr.)Perner.
Loxonema sp.
Holopella sp.
Trochonema sp.
Euomphalopteris ? sp.
Beyrichia ? sp.
Leperditia sp.
Orthoceras sp.
Orthoceras near anguliferas de Arch. and de Vern.

The occurrence of the genus *Hercynella* in this fauna is of considerable interest, since it has not been found heretofore in America. *H. bohemica* occurs in the lower Devonian of the Ural Mountains. Both *H. bohemica* and *H. nobilis* are present in Étage F of Barrande's Bohemian section. Their presence in the fauna at Long Island indicates that the latter is much more closely related to the European and Asiatic than to the American faunas outside of Alaska. This lower fauna at Long Island represents the lowest Devonian horizon which has been found in southeastern Alaska.

In the upper portion of the higher limestone, *c*, the following fauna is found:

Favosites radiciformis Rom.
Cyathophyllum sp.
Orthophyllum ? sp.
Zaphrentis sp.
Calceola cf. sandalina Lam.
Syringopora sp.
Lingula sp.
Atrypa spinosa Hall.
Atrypa reticularis (Linn.)
Atrypa hystrix Hall.
Gypidula optatus (Barr.)
Gypidula cf. intervenicus (Barr.)
Meristella cf. barrisi Barr.
Stropheodonta stephani (Barr.)
Stropheodonta comitans Barr.
Spirifer sp.
Spirifer hians Bich. ?
Spirifer thetidis Barr.
Spirifer subcomprimatus Tsch.

Spirifer sp.
Spirifer indeferens Barr.
Spirifer sp.
Reticularia ? sp.
Rhynchonella cf. amalthea Barr.
Rhynchonella livonica Buch.
Pugnax sp.
Dalmanella occlusa Barr.
Schizophora macfarlani Meek. ?
Schizophora striatula Schloth.
Streptorhynchus sp.
Camarotochia ? sp.
Cypricardinia ? sp.
Conocardium cf. bohemicum Barr.
Conocardium sp.
Lucinia cf. proavia Goldf.
Leptodesma sp.
Mytilarca ? sp.
Nuculites sp.

Telinopsis sp.
Holopella ? sp.
Loxonema ? sp.
Murchisonia sp. 2.
Murchisonia sp. 1.
Naticopsis sp.
Oriostoma sp.
Oriostoma princeps var. Oehlert.
Euomphalus cf. planorbis d'Arch. and Vern.
Tremanotus cf. fortis Barr.
Tentaculites sp.
Ooceras sp.
Gomphoceras ? sp.
Orthoceras sp.
Cytherella ? sp.
Entomis pelagica Barr.
Lepterditia sp.
Cyphaspis sp.
Proetus sp.
Proetus cf. romanooski Tsch.

In place of the gasteropods, which are the dominant forms in the lower horizon, brachiopods are the predominant group in this upper fauna. The *Hercynellas*, which are abundant at one horizon in the lower beds, appear to be entirely absent. The upper fauna, however, agrees with the lower in its foreign affiliations. In it occur the peculiar coral *Calcoela*, common in the Middle Devonian of Europe, but not recorded from the American Devonian. Several species among the brachiopods are either identical with, or have their nearest analogues in European species.

The lower 40 feet of division *c* of the Long Island section furnished a fauna differing but slightly from that of the upper part. The following list indicates its character:

Cladopora ?
Cyathophyllum sp.
Camarotoechia sp.
Meristella cf. ceras Barr.
Spirifer sp.
Spirifer cf. thetides Barr.
Spirifer cf. cheiropteryx
Stropheodonta comitans Barr.
Orthonota sp.
Schizodus sp.
Conocardium cf. bohemicum Barr.
Euomphalus planorbis d'Arch and Vern.
Oriostome princeps var. Oehlert.
Tentaculites
Cyrtoceras sp.
Orthoceras sp.
Proetus cf. romanooski Tsch.

Both faunules of this upper limestone (*c*) are regarded as representing a Middle Devonian horizon.

There are no Devonian faunas in the United States with which the Long Island faunas can be compared. Their affinities seem to be all with the European faunas.

The Middle Devonian is represented also by a fauna occurring at Freshwater Bay (4), in the northeastern part of Chichagof Island.

On the south side of the bay the Silurian series previously described in this paper is terminated by 50 feet or more of Devonian limestones. These are dark steel-gray in color, somewhat arenaceous, and lie in strata 1 to 4 feet thick. These higher beds, which are largely covered at high tide, furnished the following species:

Orbiculoidea sp.
Chonetes cf. verneuile Barr.
Camarotoechia cf. billingsi Hall.
Leptostrophia n. sp.
Stropheodonta sp.
Stropheodonta stephani Barr.
Stropheodonta cf. fugax (Barr).
Pentamarella ? sp.
Reticularia ? sp.
Schizophoria sp.
Atrypa reticularis
Cypricardinia ? sp.
Cypricardinia contexta Barr.
Goniophora sp.
Pterinea sp.
Pterinopecten sp.
Schizodus sp.
Goniatites sp.
Orthoceras sp. 1.
Orthoceras sp. 2
Bellerophon sp.
Naticopsis sp.
Oriostoma sp.
Leperditia sp.
Dalmanites sp.
Proetus romanooski (Tsch.)

This fauna has but little resemblance to any of the Devonian faunas of eastern America. Its nearest faunal equivalents are to be found in the Devonian of central Europe and Russia. Two of the species occur in Étage F of Barrande's Bohemian section. One of the trilobites which occur abundantly in this fauna appears to be identical with species described by Tschernyschew from the Ural Mountains as *Dechenella romanooski.* The presence of such forms as *Goniophora* sp., *Goniatites* sp., and *Proetus romanooski,* together with the general aspect of the fauna, points very clearly to its Middle Devonian age.

In the Freshwater Bay section igneous beds appear to occupy the entire upper Devonian interval. At Klawack (14), on the west coast of Prince of Wales Island, however, Mr. C. W. Wright made a small collection of fossils which show the presence of an Upper Devonian fauna in the southern part of the southeast Alaskan district. It contains *Zaphrentis* sp., *Productella hallana* Walcott, and *Spirifer anossofi* Vern. The two latter are represented by a number of specimens, and seem to be the most abundant fossils at the locality. *Sp. anossofi* is representative of the Ural Mountains fauna, but is closely related to *Spirifer hungerfordi* of the Iowa Devonian. *P. hallana* is a common species in the western American Devonian, and is also found in the Ural Mountains. At another locality C. W. Wright has found *Spirifer disjunctus*. The discovery of these fossils distinctly proves the presence of the Upper Devonian fauna in southeastern Alaska. In many of the sections, however, the fauna will probably be found to be absent, owing to the prevalence of submarine volcanic flows during the Upper Devonian interval.

The Devonian section of southeastern Alaska resembles that of the Upper Yukon in respect to the important rôle played by igneous rocks in each. So far as the two sections are known, however, the sedimentary members present no strong points of similarity, except that the lowest member of each is a limestone formation. The faunas of the two regions are entirely unlike each other. The Mackenzie River section, which is the nearest Canadian Devonian section of which we have any very definite knowledge,[1] appears to have no strong points of resemblance, either lithologic or faunal, to the southeastern Alaskan section.

A few other localities besides those mentioned have furnished small collections of Devonian fossils. The small number of well-known species, or the poor state of preservation of the material from these localities, makes it undesirable to offer an opinion as to the horizons represented without considerable reservation. In one of these lots, which was collected from limestone beds on the south side of Kosciusko Peninsula, are crinoid stems, *Spirorbis* sp., *Atrypa* sp., *Cyrtina* cf. *billingsi* Meek, *Meristella* cf. *barrisi* Hall, *Cranaena* cf. *romingeri* Hall, *Orthis* cf. *arcuata* Phillips, *Pleurotomaria* sp.

Devonian fossils have been reported also from Kuiu Island by Professor Charles Schuchert.[2] In describing a collection obtained by Dall and Becker from Saginaw Bay, Kuiu Island (8), he states that they "unmistakably indicate the presence there of Carboniferous and Devonian strata."[3] A careful examination of the locality from which Schuchert's fossils came failed to discover any Devonian horizon. Recently the fossils which were considered Devonian by

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[1] Canadian Geological Survey, *Contributions to Paleontology*, Vol. I, Part 3 (1891), p. 250; *Transactions of the Chicago Academy of Science*, Vol. I (1867–69), pp. 61–114, pls. 11–15.

[2] *Professional Paper No. 1*, U. S. Geological Survey, 1902, p. 43.

[3] *Seventeenth Annual Report*, U. S. Geological Survey, Part 1, p. 902.

Schuchert have been re-examined by Dr. Girty and the writer. They comprise specimens representing five or six species, most of which are common in the Upper Carboniferous fauna of Alaska. The specimens referred to *Conchidium* by Schuchert belong to the genus *Camarophoria* and are near, if not identical with, *C. margaritova.* This is a common and characteristic species of the Upper Carboniferous limestone in Alaska, not being known below it. *Spirifer* sp. undet. I is identical with a *Spirifer* collected from Carboniferous beds of Saginaw Bay by the writer, which Girty considers closely allied to *Sp. alatus* Schl. *Spirifer* sp. undet. II of Schuchert is represented only by a portion of the ventral valve, which is considerably worn. It shows traces of fine plications alternating with the seven or eight very coarse plications marking the surface. The one in the sinus is quite distinct. These minor plications distinguish it quite sharply from *S. arrecta,* with which it was compared, as well as from other Devonian brachiopods with which the writer is acquainted. The *Chaetetes* sp. undet. is probably a *Stenopora.* These supposed Devonian fossils all belong unquestionably to the Upper Carboniferous.

CARBONIFEROUS

The oldest Carboniferous fauna which has been found in southeastern Alaska was obtained at Freshwater Bay, in the northeastern part of Chichagof Island. This fauna was submitted to Dr. George H. Girty, who states, in a report furnished the writer, that, "while not unlike the American Lower Carboniferous or Mississippian, it resembles, and probably should be correlated with, the Russian Lower Carboniferous or *Productus giganteus* zone, or Mountain limestone." Freshwater Bay is the only locality visited where the Lower Carboniferous fauna has been found in southeastern Alaska. This locality is important also because the stratigraphic relation of the Lower Carboniferous to the older rocks may be observed.

On the northeastern side of the bay, and opposite the Silurian and Devonian limestones already described, the Carboniferous limestones form a low, narrow peninsula, never more than a few hundred yards in width, projecting out 4 miles from the mainland. The strike varies from N. 35° E. to N. 40° W., but generally has a northwesterly and southeasterly trend. The dip is high, frequently 90°. It is sometimes easterly, and sometimes westerly, the direction of dip depending on whether or not the limb of the large fold to which all this peninsula and the older beds on the south side of the bay belong is slightly overturned at any given point. The thickness of the several divisions of the limestones which are exposed along the north shore of this peninsula is indicated approximately in the following section, which begins about one-half mile above (northwest of) North Passage Point (2):

		Feet
e.	Breccia of large gray limestone fragments	100
d.	Hard gray limestone, much fractured by numerous irregular joints, and breaking into small irregular fragments on weathering. Large *Productoids* common. Dip 30° to 90° toward southwest; strike N. 40° W.	90
c.	Gray limestone with frequent bands of black chert. Fossils scarce. Strike N. 10° to 20° W. Dip 80° to 90° N. E.	275
b.	Dark gray limestone with black chert bands. Fossils abundant near upper and lower limits. Average strike N. 30° E. Dip 70° to 80° N. W.	250
a.	Limestone similar to *b*. Corals common	275
		990

Exposures on the north side of the bay and just west of the peninsula, which are lower but not continuous with this section, would add, if included in it, several hundred feet to its thickness. The total thickness of the Lower Carboniferous section is probably not less than 1,500 feet.

The following list, furnished by Dr. Girty, includes the more common species in the Lower Carboniferous beds at Freshwater Bay:

Zaphrentis sp.
Crinoid fragments
Diphyphyllum sp.
Productus giganteus Martin
Productus punctatus Martin ?
Productus aff. P. inflatus McChes.
Spirifer aff. S. trigonalis Martin
Cleiothyris aff. suborbiculoides McChes.

The Lower Carboniferous in southeast Alaska, while representing a different facies from that of the Mississippi Valley, is still much more closely allied to the Interior continental faunas than is the Upper Carboniferous fauna of this region. The Lower Carboniferous fauna is widely distributed in Alaska. If has been recognized as far north as Cape Lisburne, on the Arctic coast,[1] and it occurs at numerous points on the Yukon and Porcupine Rivers in eastern Alaska.

Concerning the interval between the Upper and Lower Carboniferous faunas in this region we have but few data. No fauna representing it has been found.

The younger of the two Carboniferous faunas of southeastern Alaska is well represented in the limestones about Pybus Bay, on the southeast side of Admiralty Island (7), where they outcrop extensively along both arms of the bay. The limestones characterized by this Upper Carboniferous fauna have a thickness of about 600 feet at Pybus Bay. These Upper Carboniferous limestones are generally heavy-bedded or massive, as shown in the photograph (Fig. 2). The Lower Carboniferous limestones where observed have thinner bedding and are darker-colored than those of the higher horizon.

The following section, taken along the west shore of the east arm of the bay, indicates the character of the Carboniferous limestone (*c* of the section), and the associated beds:

		Feet
g.	Black to dark-gray argillaceous slates	300
f.	Covered interval	100
e.	Massive or heavy-bedded, gray limestone, with conchoidal fracture	40
d.	Light-gray limestone full of small, angular, cherty masses	80
c.	Light-gray cherty limestone in 10″ to 30″ bands, fossils abundant	600
b.	Red chert in 6″ to 20″ bands	300
a.	Black chert in 4″ to 10″ bands, with rarely a brown or red band	550
		1,970

The Mesozoic beds are represented by the two divisions *e* and *g* of the section. Whether the shales and the Mesozoic limestone are conformable or not, the section does not show, but the latter and the Carboniferous limestone are unconformable. The total thickness of the black slates cannot be determined from the outcrops which continue beyond the end of this section, since they belong to a series of low folds which do not bring the entire thickness of the beds to view. Other outcrops, however, just outside the bay indicate a total thickness of not less than 900 feet for these black slates, which have been referred provisionally to the Lower Cretaceous by Dr. Stanton, on account of the occurrence in them of a Cretaceous type of *Aucella.*

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[1] *Bulletin No. 278,* U. S. Geological Survey, pp. 22–25.

The fauna of the Pybus Bay limestone is the same which has been previously referred to the Permian in Alaska. Dr. George H. Girty, to whom the writer is indebted for the determination of the horizons represented by the Carboniferous collections, states, however, that he finds

> that a greater resemblance exists with the Gschelian stage of the Russian section than with the Russian Permian. Provisionally, therefore, I will correlate this horizon with the Gschel-stufe, in which occur a great number of equivalent or identical species. This fauna is entirely unlike anything in the Mississippian province of the United States, but some of our western faunas resemble it.

Fossils are usually abundant and well preserved wherever the Upper Carboniferous limestone is found. The character of this fauna is shown by the following list of the species collected at Pybus Bay, which has been furnished by Dr. Girty:

Zaphrentis ? sp.
Fenestella sp.
Rhombopora sp.
Derbya sp.
Productus aff. P. gruenewaldti Krot
Productus aff. P. humboldti D'Orb
Productus aff. P. timanicus Stuck
Productus aff. P. lineatus Waagen
Productus aff. P. mammatus Keys.
Productus sp.
Rhynchopora aff. R. geinitziana Tscherny.
Spirifer arcticus Houghton
Spirifer aff. S. allatus
Spirifer n. sp. aff. S. marcoui
Spirifer n. sp. aff. S. dieneri Tscherny.
Squamularia sp.
Hustedia sp.
Spiriferina aff. S. cristata Schlot.
Cleiothyris sp.
Camarophoria margaritovi Tscherny.
Camarophoria aff. C. purdoni Davidson
Dielasma sp.
Cryptacanthia aff. C. compacta W. & St. J.
Aviculipecten sp.

In the faunas of the Halleck Harbor section Dr. Girty reports both the upper and lower series of the Gschel-stufe or upper Carboniferous faunas to be represented. This section, which is located on the north side of Saginaw Bay, Kuiu Island, follows:

		Feet
b	Light-gray limestone, locally cherty; fossils abundant	450±
a.	Black carbonaceous shales, with interbedded, dark, calcareous sandstones, arranged in belts, in which shales and sandstones alternately predominate	125+

At one point the shales and sandstones of division *a* are seen to pass along the bedding directly into cherts similar to those of Pybus

Bay. The fauna of this lower division of the section comprises the following species:[1]

Fusulina aff. F. longissima Moell.
Crania sp.
Schizophoria ? sp.
Derbya aff. D. robusta Hall
Chonetes sp.
Chonetes aff. C. trapezoidalis Waagen
Productus aff. P. humboldti D'Orb.
Productus aff. P. porrectus Kut.
Productus aff. P. semireticulatus Martin
Productus aff. P. schrenki Stuck
Productus aff. P. koninckianus Vern.
Productus cora D'Orb
Spirifer aff. S. ufensis Tscherny.
Spirifer cameratus Tscherny. non Martin ?
Squamularia n. sp.
Martiniopsis sp.
Rhynchopora aff. R. geinitziana Tscherny.
Dielasma sp.
Streblopteria sp.
Aviculipecten aff. A. mccoyi M. and H.
Aviculipecten, 2 spp.
Entolium aff. E. aviculatum Meek.
Solenopsis ? sp.

In the upper division, *b*, occur the following species:

Zaphrentis ? sp.
Stenopora sp.
Crinoid fragments
Streptorhynchus aff. S. pelargonatum Schlot.
Chonetes, 2 spp.
Productus aff. P. timanicus Stuck.
Productus aff. P. aagardi Toula.
Productus aff. gruenewaldti Stuck.
Productus aff. P. humboldti D'Orb.
Productus aff. P. mammatus Keys.
Productus aff. P. lineatus Waagen
Productus aff. P. occidentalis Newberry
Productus sp.
Spirifer aff. S. alatus Schlot.
Spirifer aff. S. blasii Vern.
Spirifer arcticus Houghton
Spirifer n. sp. aff. S. marcoui Waagen
Spirifer aff. S. dieneri Tscherny.
Spiriferina aff. S. cristata Schlot.
Squamularia sp.
Cleiothyris sp.
Camarophoria margaritovi Tscherny.
Camarophoria aff. C. purdoni Davidson
Rhynchopora aff. R. nikitini Tscherny.
Rhynchopora aff. R. geinitziana Tscherny.
Dielasma sp.

Professor Schuchert published some notes on a collecton of Carboniferous fossils from a locality near this section in 1896. The fossils were referred to Schuchert by Dr. Dall and Mr. J. A. Becker, and were collected near Point Cornwallis, which is about one mile from Halleck Harbor. Two of these, *Spirifer* sp. undet. and *Productus longispinus* var. *alaskensis* Schuchert, are reported to come from a yellow sandstone. The appearance of the fossils indicates that they came from a siliceous band in the limestone of the section.

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[1] Determined by Dr. G. H. Girty.

There appears to be no yellow sandstone member in the Saginaw Bay section. The remainder of the fossils reported by Schuchert are from a sandstone, "burnt-umber in color," which probably represents a portion of division *a* of the above section. The fossils reported by Schuchert from this "burnt umber" sandstone are:

Productus sp. undt. A	Spirifer duplicicostatus Phillips
Productus sp. undt. B	Spirifer pinguis Sowerby
Orthothetes crenistria (Phillips)	Spirifer condor d'Orbigny

The Upper Carboniferous limestone is terminated above by a Mesozoic limestone which rests unconformably on it. It is separated from the Lower Carboniferous series of Freshwater Bay by a series of cherts, dark shales, and sandstones of undetermined thickness. This limestone has a wide distribution in Alaska. In southeastern Alaska it is known on Admiralty, Kuiu, and Kupreanof islands. In the interior of Alaska the fauna of this limestone has been found in the Copper River basin by Mendenhall and Schrader,[1] and in the White River basin by Brooks.[2] The same fauna occurs on the Yukon, at the mouth of Nation River, nearly 700 miles northwest of the Kuiu Island and Pybus Bay localities. It has not been found, however, north of the Arctic circle. It is absent from the collections of both Collier[3] and Schrader[4] from northern Alaska. The writer found no trace of it in the Porcupine River section in northeastern Alaska.

In the United States the formation bearing the nearest resemblance faunally and stratigraphically to the Upper Carboniferous limestone of southeastern Alaska is the McCloud limestone of northern California. In a report on a collection of fossils from the McCloud limestone published by Mr. Diller attention is called to the similarity of the two faunas by Dr. Girty, who suggests that it is such "as to indicate the extension of this fauna and possibly of the earlier Carboniferous faunas of the California province to this region."[5] The thickness of the McCloud limestone has been estimated at from 1,000[6] to 2,000[1] feet. A thick series of shales and sandstones, with some conglomerates and calcareous lenses, underlies it.[2] Its nearest faunal relationship, like that of the Alaskan Upper Carboniferous limestone, is with the European and Asiatic province. The McCloud limestone has generally been regarded of Upper Carboniferous age.[3] By Tschernyschew it is correlated with the Upper Carboniferous or Uralian of Russia.[4]

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[1] *Professional Paper No. 15,* U. S. Geological Survey, 1903, p. 46.

[2] *Twenty-first Annual Report,* U. S. Geological Survey, Part 2, 1900, p. 359.

[3] *Bulletin No. 278,* U. S. Geological Survey, 1906, pp. 22–26.

[4] *Professional Paper No. 20,* U. S. Geological Survey, 1904, pp. 70, 71.

[5] *American Journal of Science,* Fourth Series, Vol. XV (1903), p. 351.

[6] *Geology of California,* Vol. I, p. 326.

It is very probable that representatives of the Upper Carboniferous limestones of Pybus Bay and Kuiu Island will be found in the Cache Creek[5] series of British Columbia. The data thus far published on these rocks show only that a considerable thickness of Carboniferous limestones[6] is present in British Columbia.

SUMMARY

The Silurian is represented by a limestone series probably 3,000 feet thick, holding faunas whose nearest equivalents in eastern America are the Niagaran and Guelph faunas. A series of beds aggregating several thousand feet in thickness precedes the beds known to be of Silurian age, and represents either Silurian or earlier horizons.

Lower, Middle, and Upper Devonian faunas are present in southeastern Alaska, the first resting upon beds of igneous origin. The total thickness of the Devonian is unknown. In the northern part of the region the Upper Devonian appears to be represented in part by beds of igneous origin. A limestone series about 470 feet in thickness forms the lowest lithologic series of the Devonian. *Spirifer disjunctus* and *Productella hallana* Wal. characterize the Upper Devonian fauna. Two species of *Hercynella* are the most abundant forms in the basal Devonian.

Limestones resembling somewhat the Mississippian in their fauna represent the Lower Carboniferous. These have a thickness of about

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[1] *Journal of Geology,* Vol. II, p. 600.

[2] *Ibid.*

[3] *Paleontology of California,* Vol. I, pp. 326, 327; *Journal of Geology,* Vol. II (1894), pp. 600, 601.

[4] *American Journal of Science,* Fourth Series, Vol. XXII (1906), p. 39; *Mémoire du Comité géologique,* Vol. XVI (1902 [1903]), pp. 433–51.

[5] *Bulletin of the Geological Society of America,* Vol. XII (1900), p. 70.

[6] *Ibid.,* p. 71.

1,500 feet. The highest member of the Paleozoic section in southeastern Alaska is a limestone of Upper Carboniferous age, probably the equivalent of the Gschel-stufe. At the only locality where the top of the Upper Carboniferous has been definitely located a limestone of Mesozoic age rests unconformably upon it. A series of beds, mostly limestones, having a thickness of not less than 800 feet, represents the Upper Carboniferous portion of the section.

The several faunas show comparatively little resemblance to the faunas of eastern America, while the similarity to the European and Asiatic faunas is in some cases very marked.